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Institut d'Electronique, de Microélectronique et de Nanotechnologie
UMR CNRS 8520

Master or Engineer internship 2022-2023

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Title : Towards control of structure and physical properties of graphene nanoribbons

Abstract : The ongoing rise in interdisciplinary research fields covering supra-molecular chemistry, materials and surface sciences have caused extraordinary transformation in the assembling of novel electronic devices that have remarkable functionalities like low weight, flexibility, stretchability, and transparency. The main target has been to substitute conventional top-down strategy, i.e. photo-lithography, since it requires a multi-step process including the utilization of clean rooms, high-vacuum, complex manufacture methods for masks, and releasing a lot of chemical wastes. To avoid these issues, many attempts are done to fabricate such devices by ***bottom-up methods*** that involve ***self-assembly and reaction*** of functional molecular building blocks at surfaces. Following this strategy, various miniaturized components integrated into these devices - for example sensors, transistors, solar cells – have to be interconnected by wires that are suitable for transporting electrons between them. This demand fosters the fabrication of conducting or semiconducting nanowires at the atomic scale from organic precursors. It was shown that the electron-transfer rate can be significantly enhanced in flat and rigid molecular wires compared to flexible ones. Therefore ***graphene nanoribbons*** (GNRs) elaborated from π-conjugated tectons are the most efficient 1D molecular conducting wires for passing information and fulfilling the requirements for nanoelectronics. GNRs can show both metallic and semiconducting behaviors. This makes them ideal candidates for nanocircuitry in the ***next-generation graphene-based electronics***.

This project is essentially focused at the development of several methods of on-surfaces syntheses of graphene nanoribbons relevant for application in nanodevices. It is targeted to get acquainted with UHV technology, cleaning of Au(111) single crystals with several cycles of sputtering/annealing and deposition of molecules on this metal surface by molecular beam epitaxy (MBE). Subsequent annealing of this molecular film adsorbed on metal substrate will lead to the formation of GNRs. The elaboration of these 1D nanostructures is possible due to two thermally activated *on-surface* reactions, i.e. Ullmann coupling and cyclo-dehydrogenation. Each step of GNRs growth will be monitored by scanning tunnelling microscopy (STM) providing information about their morphology and electronic structure.